The Effective Thermal Conductivity of Fluid Saturated Porous Mica-Ceramics at High Temperatures and High Pressures

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The effective thermal conductivity of unsaturated and fluid saturated porous mica-ceramics, which consist of open pores, has been measured over a temperature range from 273 K to 423 K and at pressures up to 400 MPa using a steady-state parallel-plate apparatus. It is an absolute, steady-state measurement device with an operational temperature range of 273K-1273 K and a pressure range up to 1500 MPa. We use argon and water as pore saturants. The estimated accuracy of the method is about ±2%. Measurements were performed at 273, 323, 373, and 423 K at pressures up to 400 MPa. The porosity of the samples was 7, 14, and 20 %. The effect of pressure and temperature on the thermal conductivity of the fluid (argon and water) saturated porous mica-ceramic has been studied. The thermal conductivity of gas saturated porous mica-ceramic was found to decrease the temperature dependence of the thermal conductivity with increasing pressure. The measured values of the thermal conductivity for saturated porous mica-ceramic are compared with the values predicted by various models. A new correlation based on the two-phase geometric-mean, which yields the correct temperature and pressure behavior of the effective thermal conductivity of saturated and unsaturated media, is proposed. The calculations of the effective thermal conductivity using this method showed good agreement with experimentally derived values for saturated porous materials. The effects of the size, shape, and distribution of the pores on thermal conductivity of porous mica-ceramic are discussed.

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